PART 1

Postproduction of Bedding Plants: A FOCUS ON ETHYLENE

ETHYLENE EXPOSURE CAN LEAD TO LARGE LOSSES THROUGHOUT PRODUCTION AND POSTPRODUCTION THAT CAN BE PREVENTED WITH THE RIGHT TOOLS.

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Ethylene (C_2H_4) is a colorless gaseous plant hormone with a sweet ether-like odor. It is active at very low concentrations in plants; the presence or absence of which will exhibit positive or negative effects on plant growth depending on the stage of plant development.

At proper levels, ethylene is sometimes beneficial to plant development in processes such as seed germination, flower induction in bromeliads, sex expression in squash and melons, tuber and bulb formation, removing flowers from stock plants, keeping plants short and ripening fruit. Ethylene can be harmful or damaging to horticulture crops by hastening senescence of leaves, flowers and fruit when the goal of postproduction is to extend shelf life.

Sources of Ethylene

Plants can produce ethylene internally throughout normal growth and development. Production of internal ethylene is usually triggered if plants are exposed to wounding, disease, environmental stress (high and low temperatures, flooding, drought) and ethylene itself.

Ethylene is also produced by many biological and non-biological sources. Sources of biologically produced ethylene include off gassing from fresh, processed and rotting plant material and microorganisms such as Fusarium. Sources of non-biologically produced ethylene include natural gas, incomplete combustion of fuels, engine exhaust, smoke and propane forklifts.

During greenhouse production of floriculture crops, it is important to remove these potential ethylene sources. Leaks, rust and clogging of natural gas-fired unit heaters can cause ethylene production due to incomplete combustion. Many growers reduce ventilation at night and in winter to save heat, but without proper oxygen levels, heaters cannot complete combustion and greenhouse air can become contaminated. Growing areas that are airtight such as newly glazed and iced over glass greenhouses can also result in high levels of ethylene contamination and require ventilation with clean air.

A 'Pink Pixie' lily bud showing effects of an ethylene treatment that was not quite high enough to fully kill the bud. In this case, the stamens kept growing and are protruding from the end of the bud.

Locations where combustion engines are used such as pack houses, loading bays and storage rooms should be kept separate from actively growing plants. Within these confined areas there is a need for ample fresh air, proper maintenance of equipment and removal of plant debris to reduce ethylene contamination.

In plant production facilities it can be valuable to use an ethylene-sensitive indicator plant to assess the presence of ethylene, essentially a "canary in a coal mine." For example, tomato petioles show epinasty, or a downward bending of the leaf when exposed to ethylene. The leaf will remain turgid and the plant will be otherwise healthy. When removed from the ethylene environment the leaves soon return to their normal positions.

Ethylene Damage Symptoms

Ethylene can injure plants throughout growth. Actively growing floriculture crops exposed to low ethylene levels (between 0.01 and 1 ppm) for an extended length of time (multiple days, weeks, months) can show symptoms including malformed leaves and flowers, thickened stems and leaves, stunted growth, excessive branching, abortion of flowers and leaves and abscission of flowers, buds and leaves. These symptoms can be difficult to distinguish from nutritional disorders. Exposure to high levels of ethylene — generally above 0.5 ppm — usually occurs during packaging, shipping and retailing and can cause abscission of flowers, buds and leaves, and hastening of plant death.

Symptoms can happen quickly. Sensitive crops such as impatiens can be damaged by only a few hours of exposure to ethylene, with massive flower drop with an overnight ethylene exposure.

The extent and type of ethylene damage varies with many factors including genetics (ethylene sensitivity varies between plant genus, species and cultivar), plant development (mature buds, flowers and leaves are generally first to abscise, different-sized buds can often show different sensitivity), ethylene concentration and duration (greater damage occurs with longer exposure and higher concentrations) and temperature (warmer temperatures usually increase the deleterious effect of ethylene).

Plants vary in response to ethylene. Some genera are highly ethylene sensitive such as impatiens and geranium; exposure to low levels of ethylene for a short period of time can result in flower and bud abscission. On the other hand, most genera in the chrysanthemum family (marigold, rudbeckia and zinnia) have very low sensitivity to ethylene and will recover from most symptoms (for example, epinasty) after removal from the ethylene environment. Ethylene sensitivity can vary between genus, species and even cultivars. Growers should routinely sample cultivars to observe postproduction characteristics. There may be similar color options available that are more tolerant to postproduction handling and will reduce losses.

Preventing Ethylene Damage — Cultural

Some have estimated that postproduction losses can reach 30 percent due to improper care of plants. Postproduction stresses include prolonged darkness periods in boxes, large changes in relative humidity and temperature, improper irrigation and mechanical disturbance. These stresses can lead to premature senescence symptoms including leaf chlorosis, internode elongation, flower and bud abscission, bud abortion, color fading, decreasing size of future flowers and stem dieback. Exposure to postproduction stress can also increase the effect of ethylene damage to plants. Plants that arrive at market exhibiting these senescence symptoms are unmarketable and can take weeks to recover and begin flowering again.

Proper plant culture can help reduce the negative impact of postproduction stresses on final quality. Growers should ensure plants are healthy, properly irrigated, have relatively low media EC, are free of insects or disease, have proper root growth and

A New Guinea impatiens plant exposed to 1-ppm ethylene overnight. Complete flower abscission was the result. New Guineas are extremely sensitive to ethylene.

have been grown under adequate light and temperature levels. All plants should be cleaned of old and damaged foliage and flowers before packing.

To optimize plant health in postproduction, it is best to water plants in the morning; allow them to dry and to pack plants in the afternoon when carbohydrate levels are highest. Low carbohydrate levels due to high respiration and lack of photosynthesis (in low light conditions) can also increase senescence symptoms. Plants that have been placed in sleeves or wrapped in plastic for transportation can accumulate ethylene and should have holes for ventilation, and plastic should be removed immediately upon delivery. Transportation vehicles should be refrigerated (as appropriate) and ventilated.

Preventing Ethylene Damage — Ethylene Removal and Blocking

Perhaps the simplest form of ethylene removal is to ventilate with fresh air. While this is the basis of many forms of summer bulb storage, bringing in lots of cold, fresh air into the greenhouse in the winter has an economic cost. Another method of ethylene removal is chemical absorbers, which remove ethylene from air via chemical reaction as air is passed through a matrix of the absorber. Common products include brominated activated carbon and potassium permanganate. When used, ethylene absorbers must be able to remove ethylene below the plants' ethylene threshold response concentration. Other methods include ozone and UV light to neutralize and eliminate ethylene from air.

An effective method of reducing ethylene effects is by inhibiting the ethylene molecule from binding to the receptor molecule in the plant. If the ethylene receptor site is occupied (blocked) then ethylene cannot bind to the plant, rendering the plant insensitive to the ethylene. Silver thiosulfate (STS) and 1-methylcyclopropene (MCP) are commercially available materials that inhibit ethylene from binding. STS is prevalent in the cut flower industry due to its long-lasting ability to reduce effects of internal and external ethylene. There are problems using STS because it can become phytotoxic and, in many cases, STS is most effective at concentrations close to the point of phytotoxicity. Disposal of the residual silver has become an environmental concern and some countries have restrictions of use on potted flowering plants, even though the quantities of silver involved are very, very small.

1-MCP is a gas that has been shown to be a very potent inhibitor of ethylene action. 1-MCP occupies (blocks) plant ethylene receptors and does not allow ethylene to bind. Depending on the growth of the plant, 1-MCP is effective for a few days to a week, during which plants that have been treated with 1-MCP will not be sensitive to internal or external ethylene. As flowers open and the plant grows, there will be new ethylene receptor sites produced, which will usually be susceptible to ethylene. One treatment with 1-MCP is generally sufficient to protect plants from ethylene during postproduction packaging, shipping and handling. 1-MCP can (in theory) be re-applied multiple times to plants that are subjected to longer periods of postproduction stress.

EthyBloc (Floralife Inc., Walterboro, S.C.) and Ethylene Buster (Chrysal Americas, Miami, Fla.) are commercially available 1-MCP products registered for use on ornamental plants and are available in multiple formats. 1-MCP is generally sold as a powder and the 1-MCP is released when it comes into contact with an aqueous buffer solution. 1-MCP must be released in an enclosed area for an extended period of time between four and 10 hours and is most effective at 55 to 75° F. Manufacturers' recommendations allow users to calculate the concentration of 1-MCP necessary depending on the volume of the treatment area.

EthylBloc truck-kits are used in large shipments.

Proper maintenance of gas-fired heaters is essential to eliminate potential ethylene contamination.

Depending on the size of the truck, different sizes of 1-MCP pouches are available. EthylBloc and Ethylene Buster sachets can be used for smaller shipments such as individual cut flower or potted plant boxes, and these small teabag-like sachets are filled with 1-MCP and are dipped into water and then placed inside the box, where the 1-MCP is slowly released and exposed to the plants or flowers inside. Multiple sachets can be used in one box to achieve the concentration desirable to inhibit the effects of ethylene. EthylBloc and Ethylene Buster are also available in tablet form, which when dissolved in activator solution will release a precise amount of 1-MCP.

Exposure to ethylene can lead to large losses throughout production and postproduction. Ethylene damage can be avoided by reducing exposure to known ethylene sources, maintaining equipment, ensuring proper cultural environment and removing ethylene from production and postproduction. 1-MCP can prove to be a very effective tool in protecting plants against ethylene in postproduction.

Stay tuned for Postproduction of Bedding Plants a Focus on Ethylene - Part 2 for an in-depth look at ethylene damage on bedding crops. g

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